

What is claimed is:

1. A seamless cellulose-based tubular film produced by extruding an
aqueous N-methylmorpholine N-oxide spinning solution, wherein the
tubular film comprises cellulose, at least one protein, at least one filler and
optionally, a stabilizer and wherein the proteins are soluble together with
cellulose in oxides of tertiary amines without chemical modification and
without significant breakdown of the molecular chains.
2. The seamless tubular film as claimed in claim 1, wherein the proteins are
selected from the group consisting of natural globular proteins, casein,
soybean protein, wheat protein, corn protein, peanut protein, and pea
protein.
3. The seamless tubular film as claimed in claim 1, wherein the protein
content is up to about 60% by weight of the tubular film dry weight.
4. The seamless tubular film as claimed in claim 3, wherein the protein
content is from about 8% to 45% by weight of the tubular film dry weight.
5. The seamless tubular film as claimed in claim 1, wherein the fillers
comprise organic or inorganic material.

6. The seamless tubular film as claimed in claim 5, wherein the organic fillers are selected from the group consisting of brans, microcrystalline cellulose, chitosan, guar seed meal, and carob bean meal.
- 5
7. The seamless tubular film as claimed in claim 5, wherein the inorganic fillers are selected from the group consisting of CaCO_3 , BaSO_4 , CaSO_4 , SiO_2 and TiO_2 .
- 10
8. The seamless tubular film as claimed in one of claim 5, wherein when the filler is fibrous, the maximum dimension of the fibrous filler is up to 200 μm and when the filler is particulate, the particle size of the granular filler is up to about 20 μm .
- 15
9. The seamless tubular film as claimed in claim 1, wherein an organic and/or an inorganic filler is present in the tubular film.
- 20
10. The seamless tubular film as claimed in claim 9, wherein the organic filler is precrosslinked to reduce its solubility in the N-methylmorpholine N-oxide spinning solution.
- 25
11. The seamless tubular film as claimed in claim 9, wherein the inorganic filler is insoluble in the N-methylmorpholine N-oxide spinning solution.

12. The seamless tubular film as claimed in claim 1, wherein the cellulose has a mean degree of polymerization of from about 300 to about 1100.
- 5
13. The seamless tubular film as claimed in claim 12, wherein the cellulose has a mean degree of polymerization of from about 400 to about 850.
- 10
14. The seamless tubular film as claimed in claim 13, wherein the tubular film is plasticized with glycerol and has a residual moisture of from about 8% to about 24% by weight, based on the total weight of the tubular film.
- 15
15. A process for producing a seamless regenerated-cellulose-based tubular film, which comprises extruding a spinning solution of cellulose in N-methylmorpholine N-oxide with the addition of at least one N-methylmorpholine N-oxide-soluble protein and at least one filler into a spinning bath through a ring die, the spinning solution being shaped to form the tubular film and being held in its shape by air pressure in the interior of the tubular film in the air section between the ring die and the surface of the spinning bath, and being heated by being blown with a gaseous medium.
- 20
- 25
16. The process as claimed in claim 15, wherein an inner precipitation bath of an aqueous N-methylmorpholine N-oxide solution is fed into the interior

of the tubular film through the ring die, and is continuously supplemented,
and the inner precipitation bath is removed separately from its feed.

- 5 17. The process as claimed in claim 15, wherein the tubular film is
transversely stretched and the transversely stretched tubular film is
introduced perpendicularly into the spinning bath, passes over a guide roll
and is passed out of the spinning bath perpendicularly or at an inclination
upward at an angle of from about 10° to 80° to the horizontal
- 10
18. The process as claimed in claim 17, wherein the tubular film, after exiting
from the spinning bath, passes through a wash section having a plurality
of wash vats, the tubular film being washed in the last wash vat in
- 15 countercurrent with water, which may optionally contain a microbicide
and a surfactant.
19. The process as claimed in claim 18, wherein the tubular film, after the
- 20 wash section, is treated in a plasticizer vat with a from 5 to 15% strength
glycerol solution and is then dried in a dryer having one or more
temperature zones of decreasing hot air temperatures from 120 °C to 80
°C.
- 25
20. The process as claimed in claim 15, wherein cellulose, protein and filler
are slurried together in an aqueous N-methylmorpholine N-oxide solution
and then, with vaporization of water, an N-methylmorpholine N-oxide

concentration equivalent to the N-methylmorpholine N-oxide monohydrate is obtained.

- 5 21. The process as claimed in claim 16, wherein, for the spinning bath and the inner precipitation bath, in each case the same aqueous N-methylmorpholine N-oxide solution having an N-methylmorpholine N-oxide content of from about 5% to about 50% by weight is selected.
- 10
22. The process as claimed in claim 15, wherein the drawing of the tubular film, given by the quotient of outflow speed of the spinning solution from the ring die to the take-up speed of the tubular film, is selected such that the change in tube diameter is from about -20 to about +50%, based on the
- 15 diameter immediately after the filter tube exits from the ring die.
23. The process as claimed in claim 16, wherein the N-methylmorpholine N-oxide concentration of the spinning bath and of the inner precipitation bath at the start of extrusion of the tubular film are chosen to be of equal
- 20 magnitude and, by continuous renewal of the solution of the inner precipitation bath, the increase in N-methylmorpholine N-oxide concentration toward the guide roll within the inner precipitation bath is counteracted such that the N-methylmorpholine N-oxide concentration is
- 25 kept equal to or less than the initial concentration.
24. The process as claimed in claim 15, wherein the ring die is heated to the

temperature of the cellulose/ N-methylmorpholine N-oxide spinning solution of from about 85 °C to about 105 °C.

- 5 25. An apparatus for producing a seamless cellulose-based tubular film by extruding an aqueous cellulose and N-methylmorpholine N-oxide spinning solution, said apparatus having a ring die (1) with jacket, a spinning bath (3), an air section (2) between the ring die and the surface of the spinning bath (3) and, close to the bottom of a spinning vat (4) having a guide roll
- 10 (15) for the tubular film (16), wherein the spinning solution is extruded through the ring die (1), which spinning solution comprises at least one protein and at least one filler, an extraction tube (11) for a solution of an inner precipitation bath (13) is disposed within a tube (12), the tube (12) has a smaller diameter than the tubular film (16) and is sealed by a surface
- 15 (22) of the inner precipitation bath (13) in the tubular film (16), the extraction orifice of the extraction tube (11) is mounted at an adjustable distance above the surface (22) of the inner precipitation bath (13) in the tubular film (16), and a wash device (25, 26), a plasticizing device (27) and a dryer are connected downstream of the spinning bath (3).
- 20
26. The apparatus as claimed in claim 25, wherein a feed tube (10) is passed through the tube (12), the tube (12) passes centrally through a side-fed die (7) of the ring die (1) and forms a gap (17) with a central passage (18) of
- 25 the side-fed die (7) and the feed tube (10) is height-adjustable.
27. The apparatus as claimed in claim 25, wherein the surface (22) of the inner

precipitation bath in the tubular film (16) is situated in the air section (2) between the ring die (1) and the surface of the spinning bath (3).

- 5 28. The apparatus as claimed in claim 25, wherein the distance of the extraction orifice of the extraction tube (11) from the surface (22) of the inner precipitation bath (13) in the tubular film (16) is from about 30 mm to about 60 mm.
- 10 29. The apparatus as claimed in claim 25, wherein, in the air section (2) having a length of from about 30 mm to about 100 mm, a supporting air pressure determines the diameter of the tubular film, and the inner precipitation bath (13) in the tubular film (16) which is higher or lower than the spinning bath (3), supports and reinforces by its hydrostatic pressure the diameter change.
- 15 30. The apparatus as claimed in claim 29, wherein an extrusion gap (19) of the ring die (1) is from about 0.2 to about 3 mm wide.
- 20 31. The apparatus as claimed in claim 25, wherein the ring die (1) has a jacket through which flows a heating medium (21), the temperature of which is from about 75 °C to 120 °C.
- 25 32. The apparatus as claimed in claim 31, wherein the tubular film (16)

dipping perpendicularly into the spinning bath (3) has the same caliber as the tubular film which ascends perpendicularly or at an angle of from about 10° to about 80° to the horizontal and the tubular film ascending at an incline is pressed flat below the surface of the spinning bath (3)

5

33. The apparatus as claimed in claim 25, wherein the wash device (25) comprises two or more wash vats (30, 31, 32, 33, 34), of which, in the last wash vat (34), water flows in countercurrent to the tubular film.

10

34. The apparatus as claimed in claim 33, wherein, in the plasticizing device (27), a glycerol solution is present which passes through the tubular film.

15

35. The apparatus as claimed in claim 25, wherein the dryer (28) comprises one or more drying zones in which the tubular film is dried to a residual moisture of from 8 to 24% in the inflated state with hot air with decreasing temperatures from about 120 °C to about 80 °C.

20